CONTROL STRUCTURE SELECTION FOR SERIAL PROCESSES WITH APPLICATION TO pH-NEUTRALIZATION

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We aim at obtaining insight into how a multivariable feedback controller works, with special attention to serial processes. Serial processes are important in the process industry, and the structure of this process makes it simple to classify the different elements of the multivariable controller. A serial process can be divided into a series of units, so that the states in one unit are functions of only the states in the unit itself, of the states in previous unit, and of external inputs. When the controller computes the control input from an output of the unit itself, it can be seen as local feedback control. When an upstream output determines the input, it may be called feedforward.

A multivariable controller generally uses the two principles: *"Feedforward"* action based mainly on the model (for example the decoupling elements of the controllers), and *feedback* correction based mainly on the measurements. The basic differences between feedback and feedforward control are well-known, and these differences also manifest themselves in the multivariable controller. For example a controller which is based heavily on "feedforward" action is sensitive to uncertainty at steady-state. With full multivariable controllers, we have no real feedforward, but some elements may have some of the properties of a feedforward controller. The "feedforward" elements may improve the performance significantly, but the sensitivity to model errors must be taken into account.

An example of neutralization of an acid in a series of three tanks is used to illustrate some of the ideas. A multivariable controller yields significant nominal improvements compared to local control based on PID. But this is especially due to the feedforward action, and with model error, the feedforward effect may in fact lead to worse performance.

Use of feedback from downstream pH measurements is much less dependent on the model, as use of high feedback gains at low frequencies removes the steady-state error. However, one must be careful about high feedback gains at higher frequencies due to potential stability problems, and it is at these higher frequencies one may have the largest benefit of the model-based "feedforward" action of the multivariable controller.